Individual Risk Perception and Choice using Cryptocurrency for Transactions

Li-Chiou Chen
Pace University, lchen@pace.edu

Daniel Farkas
Pace University, djf2128@gmail.com

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Short Paper

Li-Chiou Chen, PhD
Pace University
Pleasantville, NY
lchen@pace.edu

Daniel Farkas, PhD
Pace University
Pleasantville, NY
dfarkas@pace.edu

Abstract

Cryptocurrency and blockchain technology have attracted interest in a variety of applications across many industries. Understanding end-user perception of risk will assist in understanding user behavior and help to facilitate the adoption of blockchain services such as cryptocurrency. This understanding becomes more timely with the recent announcement of the cryptocurrencies Facebook Libra and Telegram Gram. Based on theories from behavioral decision science and previous studies in e-Commerce, we developed measures for risk perception, proposed hypotheses to compare risk perception using cryptocurrency with those in other domains, and designed experimental scenarios to relate risk perception to choices of using cryptocurrency. Our preliminary empirical study suggests that risk perception is of the same magnitude as online risk in e-Commerce but different from those in social and financial situations. Upon further empirical validation, we expect to gain a better understanding of user risk perception and attitude towards using cryptocurrency.

Keywords: cryptocurrency, blockchain, prospect theory, perception of risk

Introduction

Originally designed for a digital cash system (Nakimoto, 2008), blockchain technology has attracted interest in a variety of applications across many industries. Blockchains are immutable, distributed and decentralized databases that, depending on how they are implemented, allow for different degrees of anonymity, trust, and potential to be used for goods, services, and multiparty agreements. A number of papers have described different aspects of blockchain and cryptocurrency technology, applications and research possibilities (Zheng et al. 2017; Crosby et al. 2016). The original blockchain application, Bitcoin, was enhanced by the addition of "smart contracts" that enable more complex transactions in which there may be several participants and completes when conditions are met. Initially described by Nick Szabo (1994, 1996), they have been implemented in the Ethereum platform proposed in Buterin's white paper (Ethereum, 2019; Buterin, 2014).

In previous studies, risk and other factors that challenge the adoption of blockchain and cryptocurrency were extracted via interviews, web searches, literature searches and surveys (Abramova & Boeme, 2016; Folkinshteyn & Lennon, 2016; Sadhya & Sadhya, 2018; Lacity, 2018; Auinger & Riedl 2018; Holotuik & Moorman, 2018; Ostern, 2018; Mattke et al., 2018; Post et al, 2018). In some cases, risks are presented a-priori as part of the survey. However, from the behavioral and decision science literature, the perception of risk was usually measured as a relative matter and was only meaningful when compared to other risks and presented as diverse sets of activities for subjects to evaluate.

Previous study of individual risk perception was at the time when e-Commerce was beginning to gain traction (Chen & Farkas, 2009; Featherman & Pavlou, 2003). Today, e-Commerce has had disruptive effects on retail commerce and has become a dominant form of buying and selling. We were curious to investigate risk perception with the use of cryptocurrency, compare it to the same domains studied before

(social, financial and online risks), and see whether the predictive power of risk perception for e-commerce compared to risk perception for using cryptocurrency. In particular, we focus on two research questions: 1. How does individual risk perception of using cryptocurrency compare to other domains: social, financial and online? 2. How does the perception of risk influence choice making when using cryptocurrency? By investigating these questions, we expect to provide insight into how providers can better manage cryptocurrency services from the user perspective.

Understanding risk involves understanding how cryptocurrency is used from the user perspective. While peer-to-peer cryptocurrency transactions are made possible by implementing a node in a distributed and decentralized network (e.g., Bitcoin or Ethereum), many users prefer to use currency markets for transactions and hold their "wallets" (accounts) in centralized exchanges that provide trading functions for buyers and sellers. For example, Bittrex provides both buy/sell/trade capability across numerous currencies as well as holding individual wallets in multiple currencies (Bittrex, 2019). According to CoinMarketCap (Coinmarketcap, 2019) there are more than 2100 different currencies traded in more than 17,700 markets. Janze and Gvozdevskly (2017) studied the competition for trading frequency and volume in cryptocurrency exchanges. They found that frequency was driven by market and community forces (i.e., information provided by the community) while volume was driven only by the market.

The contribution of this research will be to help organizations understand risk from the end-user point of view when offering cryptocurrency services to facilitate their transactions. Based on theories from behavioral decision science and previous studies on e-Commerce and blockchain adoption, we developed measures for risk perception, proposed hypotheses to compare the perception of risk using cryptocurrency with those in other domains and designed experimental scenarios to relate the perception of risk to choice.

Literature Review

The concept of risk perception originated in behavioral and decision science (Slovic, 1987; Slovic, Fischhoff, & Lichtenstein, 1982) and was applied to information security risk in Farahmand et al. (2008). Slovic stated that "studies of risk perception examine the judgments people make when they are asked to characterize and evaluate hazardous activities and technologies." In their studies, Slovic et al. (1982) employed a psychometrics paradigm that used psychophysical scaling methods and multivariate analysis to produce quantitative representations of risk attitudes and perceptions. Using this method, researchers have typically asked individuals to judge the current and desired riskiness of diverse sets of hazardous activities, substances, and technologies. In the Information Systems (IS) area, perceived risk is commonly defined as uncertainty regarding possible negative consequences of using a product or service. Previous IS research has added "perceived risk" as an additional construct in the Technology Adoption Model (Featherman & Pavlou, 2003). In this study, perceived risk was defined as "the potential for loss in the pursuit of a desired outcome of using an e-service." There is evidence showing that the perceived risk of technology has impacted the adoption of technology such as Bitcoin, e-service, and e-government (Abramova & Böhme, 2016 ; Featherman & Pavlou, 2003; Bélanger & Carter, 2008).

There have been a number of discussions of both the risks and benefits of adopting cryptocurrency for a variety of applications. Abramova & Boeme (2016) investigated factors influencing the use of Bitcoin for purchases. Reviewing the literature, they found benefits in three dimensions: technological, economic and policy related. Risk dimensions included market, counterparty, transaction, operational, privacy, and legal or regulatory. Folkinshteyn and Lennon (2016) also looked at factors influencing the adoption of Bitcoin. They analyzed the literature using the Technology Acceptance Model (TAM) with perspectives of both users and developers. Their sources were web-based cases studies triangulated with knowledgeable stakeholders. Perceived risk for developers included business failure, security, programming and cryptographic error and regulatory uncertainty. For users, risk factors included Bitcoin volatility, security, third-party service failure and user error.

Focusing on institutions and enterprises, there have been several reports and studies exploring the current state as well as challenges to the adoption of blockchain technology and cryptocurrency. Sadhya & Sadhya (2018) looked at web-based sources and identified 16 barriers to adoption. These included regulatory issues, privacy, security, implementation issues, startup costs, lack of trust, transaction scalability, energy utilization, ease of use, storage concerns, and technical maturity. Recognizing that transactional risk and

uncertainty exist in inter-organizational supply chains, Naerland et al. (2017) described a blockchain project and how design principles could mitigate the risk and uncertainty

Lacity (2018) identified four areas of concern: standards, regulations, shared governance, and a viable ecosystem presenting three case studies that included startups, traditional enterprises and consortia. Auinger and Riedl (2018) analyzed trust as related to blockchain. An analysis of 61 papers, in contrast to "trust-free", they identified, more specifically, trust in algorithms, technological mechanisms, and trust and disintermediation as the top themes. Holotuik & Moorman (2018), basing their framework on "technology, organization, and people" identified factors affecting adoption in several categories including technology, organization and people, but also including project management, and the technological environment external to the organization.

Ostern (2018) explored the shift of trust from individuals and institutions to trust in the technology. The study used a structured questionnaire sent to online forums and identified several factors that foster or hinder blockchain trust. These include security, development aspects (e.g., no central authority), disintermediation, data protection and privacy, convenience, personal factors (e.g. willingness to learn), lack of knowledge, economic factors, and external aspects including news and opinions of others. Mattke, et al. (2018), using fuzzy set qualitative comparison analysis (fsQCA) identified several influencing factors: transition and uncertain costs, loss aversion, learning curve, sunk costs, anticipated regret, and whether one will have the freedom to use or not use Bitcoin as payment. Using 18 semi-structured interviews, Post et al. (2018) identified 13 factors affecting blockchain diffusion in three categories, strategic (e.g. compliance, organization size), tactical (e.g., knowledge deficit, viable use cases), and operational (e.g., technological shortcomings and process maturity).

Given that the literature identified multiple factors inhibiting the adoption of blockchain technology using cryptocurrency, these factors might play either an implicit or explicit role in shaping user perception of risk. The focus of this paper is to investigate individual user perception of risk and how that might effect choice when using cryptocurrency.

Hypotheses Development

For organizations that offer goods or services and are considering cryptocurrency as a payment option, understanding end-user perception of risk will facilitate decisions related to adopting these services. Although the original design of cryptocurrency was to provide a digital cash system that prevents double-spending (Nakimoto 2008), previous studies have shown that other risks are factors that significantly impact its adoption (Abramova & Boeme 2016; Folkinshteyn and Lennon 2016). How do end-users of blockchain services perceive these risks when using cryptocurrency? What risks do they perceive when using cryptocurrency for transactions? Is their perception of risk aligned with actual risk? We focus on cryptocurrency as our use case as it is the original and most prevalent application of blockchain. Our goal is to better assess how users make choices when engaging in cryptocurrency activities. An understanding of how users make these choices and how the perception of risk influences these choices may provide institutional insight into offering cryptocurrency services. For example, for companies selling internationally, if they offer cross-border cryptocurrency services as a payment option, will consumers use them?

We studied these questions by looking at the multi-faceted perspectives of risk emerging from using cryptocurrency for transactions from the user point of view. First, needed to investigate the perception of risk in different activities relating to cryptocurrency, such as purchasing goods, services or investments as well as for buying, selling or holding cryptocurrency. Second, we developed observable measurements to assess the perception of risk. Third, we compared the perception of risk with those in other domains. Last, we plan to relate to perception of risk to choice in different cryptocurrency scenarios.

There are typically two different ways for a user to execute cryptocurrency transactions. When self-managed, users maintain currency wallets locally on a computer that is part of a blockchain network (e.g., Bitcoin or Ethereum). They place transactions directly onto the network, interacting with other cryptocurrency participants. In a second, intermediary method, users sign up with a currency exchange on a remote server that maintains the user's currency wallet. The exchange serves as an intermediary to manage transactions on the behalf of its users. Whether local (decentralized) or using an exchange (centralized), users are engaging in activities that are similar to e-Commerce. Instead of using credit cards

to pay for goods or services, users provide cryptocurrency wallet information to complete transactions. In the case of blockchain, transactions are validated according to a blockchain consensus protocol (e.g., proof of work). For traditional e-Commerce transactions, centralized authorities (e.g. banks or credit card companies) validate and complete the transactions.

Both the perceived risk of using cryptocurrency and the trustworthiness of e-Commerce providers have an impact on user behavior and intention to engage in commercial transactions. We argue that using cryptocurrency has similar properties to e-Commerce for end-users. First, both require specialized computing platforms to conduct transactions. Cryptocurrency uses blockchain technology and e-Commerce uses bank credit card payment transaction centers. Second, both rely on user trust in their respective systems. Blockchain trust is embedded in either its technology (decentralized) or in the centralized exchanges. E-Commerce relies on the reputation of the banks, credit card companies and retailers that have an online presence. Third, both deal with online risks that involve computer networks to conduct transactions. Because of these similarities, we define hypothesis H1 below. For hypothesis H2, we follow Weber's prediction (Weber et al., 2002) in which the perception of risk is domain specific.

> H1: User perception of risk using cryptocurrency is of the same magnitude as the perception of risk in situations that directly involve online risk.
>
> H2: User perception of risk using cryptocurrency is of a different magnitude as the perception of risk in situations that do not directly involve online risk.

Risk attitude refers to an individual's decisions or preferences regarding risk-related choices. This topic has drawn abundant research in the field of individual decision-making. Prospect theory (Tversky and Kahneman 1981, 1986) has been the most cited theory in this field since it explains the empirical evidence that violates assumptions in the classical expected utility theory (Friedman and Savage, 1948; Machina, 1990) in Economics where an individual's risk attitude is a function of risk preference, outcomes, and the probability of occurrence. Prospect theory explains that people tend to overweigh outcomes that are considered certain in comparison to outcomes that are merely probable (Tversky and Kahneman, 1981). Based on this theory, individuals tend to be risk averse in terms of gain and likely to choose gain that is certain over probable gain. In addition, individuals tend to be risk seeking in terms of loss and are likely to choose probable loss over loss that is certain.

As Abramova & Boeme (2016) pointed out, cryptocurrency presents a higher level of market risk than a stable currency since the value of cryptocurrency fluctuates more than stable currency. To use cryptocurrency for e-Commerce transactions, users are facing the choice of using a regular traditional payment method verses using cryptocurrency with probable gain or loss in the near future due to market fluctuation. Based on Prospect Theory, our research would like to hypothesize user choice of payment methods in two situations: spending and earning. When users spend on transactions, they are facing the choice of a certain loss (spend with a stable currency) verses probable loss (spend with cryptocurrency). When users earn from transactions, they are making the choice of a certain gain (earn in a stable currency) verses probable gain (earn in cryptocurrency). Therefore, following the prediction of Prospect Theory (Tversky and Kahneman, 1981), we hypothesize H3 and H4 for cryptocurrencies that do not bind to a stable currency.

> H3: In case of spending, users tend to be risk seeking and are therefore more likely to adopt cryptocurrency than traditional means of payment, such as credit cards.
>
> H4: In case of earning, users tend to be risk averse and are therefore more likely to adopt traditional means of payment than cryptocurrency.

Stable coins are a type of cryptocurrency that is pegged to a stable asset such as gold or the U. S. dollar thus avoiding market risk in value (Lee, 2018). For transactions with stable coins, such as the proposed Facebook Libra (Seward and De, 2019), a user's choice of payment methods would be very similar to that of traditional online payment since they both are subject to the same types of online risk. Therefore, we hypothesize H5 below.

> H5: For cryptocurrency that binds to a stable asset, users will be as likely to use cryptocurrency as a traditional means of payment.

Empirical Study Design

Development of Measures for Risk Perception

To examine H1 and H2, we identified a set of activities that users would engage in using cryptocurrency. These activities were presented as measures to assess user perception of riskiness engaging in these activities. For comparison, we adopted measures from previous studies on decision-making (Weber, et. al 2002) and e-Commerce (Chen and Farkas 2009) in three other domains: social, financial including investment and gambling, and online activities relating to computer security. Appendix A shows the list of measures that we developed for comparing the perception of risk. These measures were analyzed using factor analysis for their correlation to their respective domain.

Created for this study, the cryptocurrency measures were based on two types of situations. The first involves how users manage cryptocurrency transactions. In some cases, users maintain their currency addresses (wallets) on their own computer. This contributes to anonymity and the decentralized, distributed and disintermediated blockchain ecosystem. Wallet management including security, transactions and accounting are the responsibility of the user. An alternative involves using an exchange in which user wallets are stored in a centralized platform. The second situation addresses the use of cryptocurrency as an exchange for assets. Examples include purchasing goods and services and investing in real-world assets. Tokens or coins have been created for investment or fundraising of startups or as representative of ownership in real-world assets. Oliveira et al. (2018) gives an overview and classification of token usage and types that include cryptocurrency, equity, funding, consensus, work, voting rights and payment. Specifically for funding, Chanson et al. (2018) describes initial coin offerings (ICOs) and how they are used. Note that we are investigating risk perception related to the use of cryptocurrency without regard to the risk nature of an asset (e.g., fine art, investment, etc.).

Relating Risk Perception to Risk Choices

To examine hypotheses H3, H4, and H5, we will develop two scenarios involving choice of payment methods using either cryptocurrency (Bitcoin) or traditional methods (credit cards/bank accounts). The expected values of the options in both scenarios are the same. We will conduct an ANOVA analysis to compare choices as well as correlate respondent choices to their risk perception measures. In both scenarios, Option A is an option without uncertainty and Option B is a cryptocurrency option with uncertainty, similar to a lottery, with an expected value that is equal to Option A. Option C is the cryptocurrency option without uncertainty. Following scenarios in Prospect Theory (Tversky and Kahneman, 1981), scenario 1 provides choices regarding loss while scenario 2 provides choices regarding gain.

Scenario 1 - Payment Choices in Spending: Consider a spending scenario in which you have ordered a cellphone that costs $500. Which of the following payment methods would you prefer?

Option A: Pay $500 using a traditional method such as a credit card.

Option B: Pay $500 in Bitcoin, However, at the end of the month, the $500 in Bitcoin has a 25% chance to be worth $600, has a 25% chance to be worth $400, and has a 50% chance to be worth the same.

What is your choice if Option B is changed to Option C below?

Option C: Pay $500 in a cryptocurrency whose value is tied to the U.S. dollar. Its value, relative to the dollar, will not change.

Scenario 2 - Payment Choices in Earning: Consider an earning scenario in which you are selling your used cellphone online for $500. Which payment method would you prefer?

Option A: Receive traditional payment such as a bank transfer for $500.

Option B: Receive $500 in Bitcoin, However, at the end of the month, your $500 in Bitcoin has a 25% chance to be worth $600, has a 25% chance to be worth $400, and has a 50% chance to be worth the same.

What is your choice if Option B is changed to Option C below?

Option C: Receive 500 in a cryptocurrency whose value is tied to the U.S. dollar. Its value, relative to the dollar, will not change.

Data Collection

The instrument containing risk perception measures, deployed as a web-based survey in April 2019, asks subjects to rate 20 activities using a five-point Likert scale. For each activity, the subjects were asked to express how risky they perceived this activity (to elicit their perception of risk). These activities, listed in Appendix A, include risks in four different domains: social situation (social), financial situation (financial), online activities relating computer security (online), and cryptocurrency transactions (crypto). Cryptocurrency transactions are divided into two types corresponding to the two situations described above: currency management (crypto-mgmt) and cryptocurrency for assets (crypto-asset). The participants in the study were graduate and undergraduate students attending a university in the Northeast United States. Currently, we collected 45 usable samples excluding incomplete responses. The survey asked the respondents their level of blockchain understanding on a Likert scale from 1-5 (Extremely, Very, Moderately, Slightly, No knowledge). The distribution for all respondents was 0.0%, 15.4%, 40.0%, 36.9%, and 7.7% respectively.

Preliminary Results

On average, the perception of risk is highest in financial measures and lowest in social measures. Both online and cryptocurrency measures are in between the other two domains. Table 1 shows the descriptive statistics of the 20 measures in four domains.

Domain	Minimum	Maximum	Mean	Std. Dev.
social	1.00	4.25	2.06	0.75
financial	1.25	4.25	3.02	0.61
online	1.50	4.00	2.81	0.63
crypto	1.38	4.00	2.82	0.62

Table 1. Descriptive Summary of Measures for Perception of Risk

Comparisons between Group Means

We calculated the means of measures in each domain for each subject and then conducted paired sample tests between cryptocurrency measures and each of the three other domains. We found that the perception of risk using cryptocurrency is significantly higher than those in social situations (99% statistically significant), significantly lower than those in financial situations (90% statistically significant), and no statistical difference compared to those in online activities relating computer security. As in Table 2, these results confirm hypotheses H1 and H2. The difference between cryptocurrency measures and the social and financial measures confirm the findings from a previous study (Weber et al. 2002) that risk perception is domain specific. When comparing to risk perception in online activities developed by Chen and Farkas (Chen and Farkas 2009), cryptocurrency measures show no significant difference in group means but we need to further investigate the results by validating internal and external consistency of the domain measures.

Difference of group means	Mean	Std. Dev.	Std. Error Mean	t	Sig.(2-tailed)
crypto - social	0.76	0.70	0.10	7.26	0.00***
crypto - financial	-0.20	0.76	0.11	-1.77	0.08*
crypto - online	0.01	0.70	0.10	0.05	0.96

Table 2. Paired Samples Test on Paired Difference (df=44);

*****significant at 99%; significant at 90%**

Factor Analysis of Risk Measures

In order to explore the consistency of the measures that we developed (Straub and Gefen 2018; Price, et. al 2018)), we conducted factor analysis of the measures. In SPSS, we used Principal Component Analysis as the extraction method since we have pre-defined groups for the measures. The analysis used Oblimin with Kaiser Normalization as rotation method because the clusters of our measures are not situated in perpendicular direction (Brown 2009). Table 3 shows the loadings that are larger than 0.3 for the 20

measures. These measures are loaded into five components, which explain 60% of the variance. The results shows that six of the eight cryptocurrency measures loaded to the same factors. Since factor analysis requires a sample size that is about 20 times of the measurements to obtain results in good quality (Costello and Osborne 2005), we plan to collect additional data in further analysis.

	1	2	3	4	5
crypto1	0.734			-0.442	
crypto2	0.605		0.418		-0.318
crypto3				0.76	
crypto4	0.63				
crypto5	0.577	0.361		0.438	
crypto6					0.583
crypto7	0.835				
crypto8	0.604	-0.367			
online1			0.696		
online2		-0.671	0.319		
online3			0.666		
online4					0.82
financial1		0.64			
financial2	0.327	0.326	-0.399		0.485
financial3			0.577	-0.509	
financial4	0.357				
social1				0.629	
social2		-0.837	-0.305		
social3	0.487	-0.605			
social4		-0.381			

Table 3. Factor Analysis of All Measures on the Perception of Risk

Future Work and Expected Progress

Between submission of this paper and December 2019, we expect to review additional literature published in the meantime, complete additional data collection and analyze new data to validate the hypotheses. For data collection, we plan to broaden participation from 45 respondents to around 300 using the Qualtrics Research Service, which creates survey panels according to user filtering parameters. For data analysis, we will review and update the risk perception measures based on the initial study. In addition, we plan to add the two scenarios that elicit subjects' risk choices in cryptocurrency to examine hypotheses H3, H4, and H5.

Conclusion

We developed theories and an empirical study to examine the predictive power of risk perception in comparison with those in other domains, in particular, online risks that are typically encountered in e-Commerce situations. Our preliminary results show that users perceive the same magnitude of risk as online risk but a different magnitude of risk in other domains including social and financial situations. We have developed an empirical study to further relate the perception of risk to choice. Upon further empirical validation, we expect that the understanding of risk perception and attitude will offer organizations insights into how users would make choices under these risk situations. In theory, we further the understanding of the domain-specific nature of risk perception and how it relates to risk choices. In practice, we provide insights into the potential adoption of cryptocurrency through the understanding of user perception of risk.

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Appendix A

Label	**Survey Questions:** For each of the following statements, please indicate how risky you perceive each situation.
crypto1	Purchasing cryptocurrency using an exchange connected to one's bank (crypto-mgmt)
crypto2	Using cryptocurrency to buy a token/share of an asset (crypto-asset)
crypto3	Using a cryptocurrency to engage in an asset transaction considering as regular expenses (e.g.: order lunch) (crypto-asset)
crypto4	Using a cryptocurrency to engage in an asset transaction considering as an investment (e.g.: purchase a house) (crypto-asset)
crypto5	Investing in an ICO (Initial Coin Offer) (crypto-asset)
crypto6	Using a local "wallet" to store cryptocurrency (crypto-mgmt)
crypto7	Using an "Exchange" to store cryptocurrency (crypto-mgmt)
crypto8	Making a purchase using a "stable" cryptocurrency tied to the value of the US Dollar (crypto-mgmt)
online1	Clicking on a unknown web link sent by a friend through emails
online2	Viewing a funny video clip directly streaming from a web site
online3	Managing bank accounts online
online4	Purchasing a product from an online merchant that you have not heard of before
financial1	Investing 10% of your annual income in government bonds
financial2	Investing 5% of your annual income in a conservative stock
financial3	Betting a day's income at a high stake poker game
financial4	Investing 5% of your annual income in a very speculative stock
social1	Wearing provocative or unconventional clothes on occasion
social2	Admitting that your tastes are different from those of your friends
social3	Arguing with a friend about an issue on which he or she has a very different opinion
social4	Defending an unpopular issue that you believe in at a social occasion

Table 4. Survey Questions (crypto1-crypto8 were developed by this study, online1-online4 were from Chen and Farkas, 2009, and the rest were from Weber et al., 2002.)